

- Dr. MOND, Professor RAMSAY, and Dr. J. SHIELDS. On the Occlusion of Oxygen and Hydrogen by Platinum Black. Part II.
- J. E. MURRAY. On Contact Electricity of Metals.
- W. GARDINER. The Histology of the Cell Wall, with Special Reference to the Mode of Connection of Cells.
- H. L. CALLENDAR and H. T. BARNES. On the Variation of the Electromotive Force of Different Forms of the Clark Standard Cell with Temperature and with Strength of Solution.
- Lord RAYLEIGH. On the Viscosity of Hydrogen as affected by Moisture.

The following Papers were read:—

- I. "Account of a Comparison of Magnetic Instruments at Kew Observatory." By C. CHREE, Sc.D., F.R.S., Superintendent.
- II. "Note on the Influence of very Low Temperatures on the Germinative Power of Seeds." By HORACE T. BROWN, F.R.S., and F. ESCOMBE, B.Sc., F.L.S.
- III. "On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. II. On *Spencerites*, a new Genus of Lycopodiaceous Cones from the Coal-measures, founded on the *Lepidodendron Spenceri* of Williamson." By D. H. SCOTT, M.A., Ph.D., F.R.S., Hon. Keeper of the Jodrell Laboratory, Royal Gardens, Kew.
- IV. "Antagonistic Muscles and Reciprocal Innervation. Fourth Note." By C. S. SHERRINGTON, F.R.S., and Dr. E. H. HERING.

At the request of the President, Mr. Gardiner made an oral statement on the subject of his Paper published during the vacation (see list above).

"Account of a Comparison of Magnetic Instruments at Kew Observatory." By C. CHREE, Sc.D., F.R.S., Superintendent.
Received October 26,—Read November 18, 1897.

Last July, M. T. Moureaux, of the Parc Saint-Maur Observatory, near Paris, brought over to England the travelling instruments employed in his magnetic survey of France, and a comparison was made between these and the standard magnetic instruments at Kew Observatory. At the expressed desire of the Kew Observatory Committee, I submit on their behalf a brief account of the comparison and its results.

The comparison serves to connect the standard instruments at Kew Observatory with the standard French instruments at Parc Saint-Maur, the latter, as M. Moureaux has had the goodness to

inform me, being in excellent agreement with his travelling instruments. Parc Saint-Maur may be regarded as the base station for M. Moureaux's great survey of France and Algeria, while Kew Observatory performed a similar function in the surveys of Great Britain and Ireland, by Professor Rücker and Dr. Thorpe. The existence of the English Channel introduces uncertainty into any conclusions based on the trend of the magnetic lines in France and England, and the instruments employed in the two countries are sufficiently dissimilar to justify scepticism as to their close agreement in the absence of direct experiment. The interest of the comparison is thus far from being limited to the two observatories most immediately concerned.

M. Moureaux's observations at Kew Observatory occupied the afternoon of July 26, and the forenoons of July 27, 28, and 29. On the afternoons of the last three days, observations were made with the Kew standard instruments, by Mr. T. W. Baker, chief assistant at the Observatory. All the observations were made in the "magnetic house" in the Observatory garden.

The comparison was really between M. Moureaux's absolute instruments and the Kew absolute instruments, but the observations, being made at different hours of the day, had to be connected through the intermediary of the curves from the self-recording magnetic instruments. The elements recorded photographically are the declination, horizontal force, and vertical force. The value in magnetic units of 1 cm. of the ordinates is known, but the value of the base lines, answering to zero ordinates, of the several curves is to a certain extent variable. The usual practice at Kew Observatory is to treat each month separately, deducing the value of the base line for any element from a comparison of the absolute observations for that month with the curve ordinates at the times of the observations.

In the case of the declination and horizontal force, the standardization of the curves is comparatively simple. In the case of the vertical force, the influence of temperature is unfortunately somewhat large, a rise of 1° F. equalling in effect a fall of 0.0001 C.G.S. unit in the vertical component. There is also the complication that what the curve gives is the vertical force, while what the absolute instrument gives is the inclination.

Thus to compare inclinometers used at different hours, one has to follow a circuitous route by way of the horizontal and vertical components, allowing a correction for changes of temperature in the magnetograph room during the observations.

M. Moureaux observed the inclination early, and Mr. Baker late, in the day, and there happened to be a slight difference in the mean temperature of the magnetograph room at the times of their observations.

Taking into consideration the above facts, and the further fact that M. Moureaux's visit occurred at the end of a month, it was decided to standardise the curves exclusively from Mr. Baker's special observations, on July 27 to 29. These gave three or more complete determinations of each element, under conditions which might be described, on the evidence of the curves, as an almost perfect magnetic calm.

Mr. Baker's absolute observations and the corresponding curve measurements were in good agreement, especially in the case of the horizontal force, where the individual calculated values for the base line of the curves showed no difference greater than 0·00002 C.G.S. unit.

Owing to the less direct method of comparing the inclinometers, I regard the results obtained for them as somewhat less trustworthy than the others.

The figures under the heading "Observatory—Moureaux" are to be regarded as the excess in the readings of the absolute Kew instruments over those of M. Moureaux's instruments, supposing the former to have been read simultaneously with the latter. The times specified are actually those occupied by M. Moureaux's observations.

Declination.

Date.	Time.	Kew		Observatory—
		Observatory.	Moureaux.	Moureaux.
July 26	3.47— 4.2 P.M.	17° 5'9"	17° 5'7"	+ 0'2"
27	10.5 —10.18 A.M.	4'8	5'0	— 0'2
27	10.22—10.32 „	6'0	5'7	+ 0'3
28	9.9 — 9.24 „	2'1	1'3	+ 0'8
28	9.28— 9.40 „	3'0	1'9	+ 1'1
29	11.37—11.49 „	9'9	9'3	+ 0'6
Mean.....				+ 0'5'

Horizontal Force.*

Date.	Time.	Kew		Observatory—
		Observatory.	Moureaux.	Moureaux.
		C.G.S.	C.G.S.	(Unit being 10 ⁻⁵ C.G.S. unit).
July 26	4.13— 4.42 P.M.	0·18354	0·18356	— 2
27	10.41—11.10 A.M.	25	24	+ 1
28	9.48—10.18 „	28	49	— 21
28	10.43—11.11 „	20	39	— 19
29	10.24—10.56 „	20	43	— 23
29	11.1 —11.31 „	20	27	— 7
Mean....				— 0'00012 C.G.S. unit.

* [Nov. 15, 1897. M. Moureaux requests me to explain that in the present comparison of horizontal force at Kew—as well as in his recent comparisons at

Inclination.

Date.	Time.	Kew		Observatory—	
		Observatory.	Moureaux.	Moureaux.	
July 27	11.15—11.41 A.M.	67° 20' 2"	67° 18' 9"	+ 1' 3"	
28	11.21—11.43 „	20' 3"	18' 7"	+ 1' 6"	
29	8.55— 9.18 „	19' 8"	17' 3"	+ 2' 5"	
29	9.21— 9.43 „	20' 0"	17' 6"	+ 2' 4"	
29	9.47—10.9 „	20' 0"	18' 0"	+ 2' 0"	
Mean.....				+ 2' 0"	

In judging of the results several things merit consideration. Neither inclinometer read to less than 1', decimals arising from arithmetical operations. The Kew unifilar magnetometer reads to 10'', but with M. Moureaux's much smaller instrument readings could not be taken to less than 30''. The great skill of the two observers is beyond question, and the mean of several results obtained without mental bias may possess an accuracy greater than that which any individual reading can lay claim to. Still, personally, I should be very sorry to claim accuracy of the order of 1 in the last significant figure of the mean differences.

In the use of the results, one should remember the possibility, or rather probability, of the occurrence of change in magnetic instruments. This is a vicissitude to which travelling instruments are probably most exposed, but even in an observatory standard it is certainly not impossible. The constant "P," appearing in the factor $1 - Pr^{-2}$, which allows for the departure of the horizontal force magnet from the ideal infinitely short magnet, appears to be to some extent variable, at least in the Kew instrument. This particular variation does not necessarily affect the calculated horizontal force, because the proper value of "P" for a special set of observations can be calculated from the experiments themselves. This precaution was, in reality, actually adopted in the present case. Still the fact that a change does take place, which, if undetected, would appreciably influence the results, shows that assumptions of absolute constancy are at present acts of faith, not reason. Until there exists a regular system of intercomparison of the instruments at different observatories, our information on this head is likely to be limited.

Pavlovsk (St. Petersburg) and Uccle (Brussels)—he has made use of new values for the constants of the French instruments, which it is intended to apply consistently after Jan. 1, 1898.

This change, entailing a reduction of 0.00067 C.G.S. unit in the corrected readings of the French standard, was postponed until the French survey should be completed, though the necessity for it has been recognised for some years. Particulars will be found in a paper by M. Moureaux in the 'Annales du Bureau Central Météorologique de France,' vol. 1, 1896, now in the press.]

After this remark, I think I may safely utilise the present comparison to extend a table,* in which Professor Rücker and Mr. W. Watson embodied the results of their comparison of the standard instruments at various English and Irish observatories, made by means of travelling instruments, in 1895. The differences between the declination, horizontal force, and inclination instruments are given in order, one below the other, the unit in the case of the horizontal force being 0·00001 C.G.S. unit.

The table is to be read as follows:—"Standard declinometer at Kew reads higher than that at Parc Saint-Maur by 0·5', but lower than that at Falmouth by 0·8'," and so on. The last column gives the differences from the mean instrument, so to speak, of the five observatories.

	Kew.	Parc Saint-Maur.	Fal-mouth.	Stony-hurst.	Valencia.	Mean.
Kew Observa- tory	{ —	+ 0·5'	— 0·8'	+ 1·1'	0·0'	+ 0·2' }
	{ —	— 12	— 18	— 6	+ 29	— 1 }
	{ —	+ 2·0'	— 1·6'	+ 2·2'	— 1·8'	+ 0·2' }
Parc Saint- Maur	{ — 0·5'	—	— 1·3'	+ 0·6'	— 0·5'	— 0·3' }
	{ + 12	—	— 6	+ 6	+ 41	+ 11 }
	{ — 2·0'	—	— 3·6'	+ 0·2'	— 3·8'	— 1·8' }
Falmouth . . .	{ + 0·8'	+ 1·3'	—	+ 1·9'	+ 0·8'	+ 1·0' }
	{ + 18	+ 6	—	+ 12	+ 47	+ 17 }
	{ + 1·6'	+ 3·6'	—	+ 3·8'	— 0·2'	+ 1·8' }
Stonyhurst . .	{ — 1·1'	— 0·5'	— 1·9'	—	— 1·1'	— 0·9' }
	{ + 6	— 6	— 12	—	+ 35	+ 5 }
	{ — 2·2'	— 0·2'	— 3·8'	—	— 4·0'	— 2·0' }
Valencia (Ca- hirciveen)	{ 0·0'	+ 0·5'	— 0·8'	+ 1·1'	—	+ 0·2' }
	{ — 29	— 41	— 47	— 35	—	— 30 }
	{ + 1·8'	+ 3·8'	+ 0·2'	+ 4·0'	—	+ 2·0' }

The apparent agreement between the standard instruments at Parc Saint-Maur and Stonyhurst is noteworthy. The fact that the Kew standard instruments agree so closely with the imaginary mean instruments was, it may be observed, not noticed by the writer until after he had constructed the table. In his opinion the phenomenon is probably purely fortuitous. In searching, however, for explanations of the discrepancies between the several instruments, or in attempting to remove them, a consideration of the departures from the means might be profitable.

* 'Brit. Assoc. Report' for 1896, p. 97.